Graphene composite electrospun fibres: mechanical and morphological characterization

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Abstract

Nanocomposites is a rapidly growing field of research. In fact, the properties of materials can be tailored with the use of fillers and applications can be found in many sectors.

Among the fillers, in order to improve the mechanical properties of the polymer matrix already at very low fillers' concentrations, graphene and its derivatives are by no doubt particularly suited for this purpose due to its extremely high intrinsic values of mechanical properties [1]. For instance, graphene in the oxidized form enstablishes an higher interfacial adhesion with the matrix, which is a crucial factor for load transfer [2].

In this study, mechanical tests on single graphene composite electrospun fibres are shown for the first time.

Electrospinning technique allows to produce very thin fibres, whose diameters range from hundreds of nanometres to some micrometres. Electrospinning was used to produce composite fibres; single fibres were carefully isolated and tested with a Nanotensile machine to understand the effect of fillers in composites at the lowest hierarchic level, nanofibres.

PVDF fibres showed high specific toughness values up to 60% of that of Kevlar fibres [3] and an impressive value of 540% strain at break. The mechanism of energy dissipation is explained by a microstructural interpretation of the fibres after testing. The different behaviour of polymer and composites is compared.

References

[1] C. Lee et al., **Science**, 321.5887 (2008) 385-8
[2] R. J. Young et al., **Composites Science and Technology**, 72.12 (2012) 1459-1476
[3] M. K. Shin et al., **Nature communications**, 3 (2012) 650

Figures

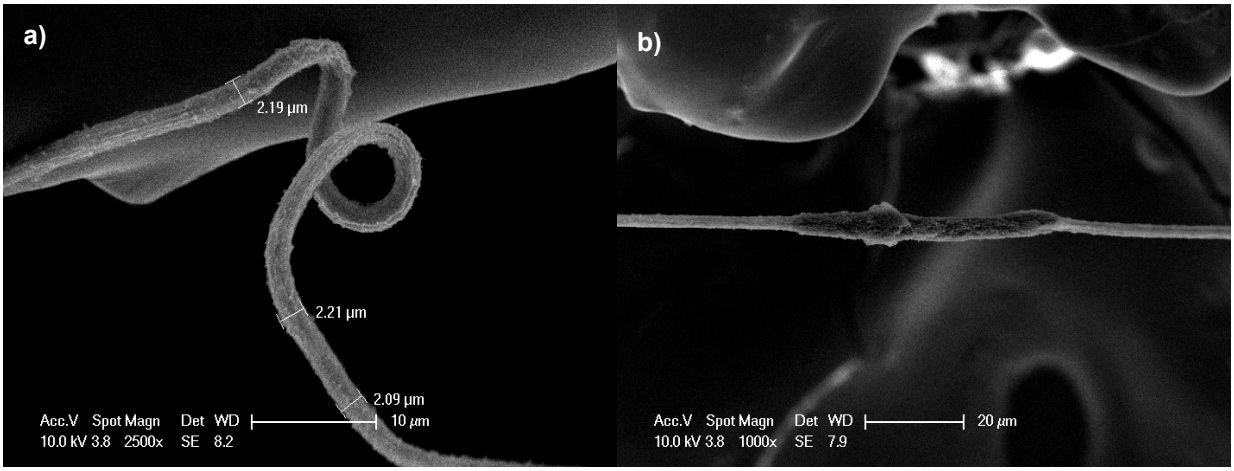

Fig. 1. a) composite fibre after mechanical testing, b) composite fibre underwent plastic deformation at the 2 sides of a stiffer region where a large graphene flake is visible.